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Grid Stability Awareness System (GSAS) - A Software Suite for Stability Monitoring and Analysis (DOE-OE0000700)

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Project Overview

- **Objectives**
  - Develop a suite of production level software applications (named Grid Stability Awareness System - GSAS) for power grid real-time monitoring and analysis of oscillation stability, voltage stability and transient stability.
  - Deploy the software suite to one of Southern Company's control centers
- **Project Duration**
  - 10/1/2014 - 12/31/2016
- **Funding**
  - DOE Funds: $1,458,181 (48.6% of total budget)
  - Recipient cost share: $1,541,936 (51.4% of total budget)
- **Partners**
  - Southern Company
  - Washington State University
  - Grid Protection Alliance

Project Achievements

Developed a software suite: Grid Stability Awareness System - GSAS

- Oscillation monitoring tool
- Voltage stability monitoring tool
- Angle instability monitoring tool
- Angle difference monitoring tool
- Event detection tool

Deployed the software suite on Southern Company's real-time synchrophasor facilities

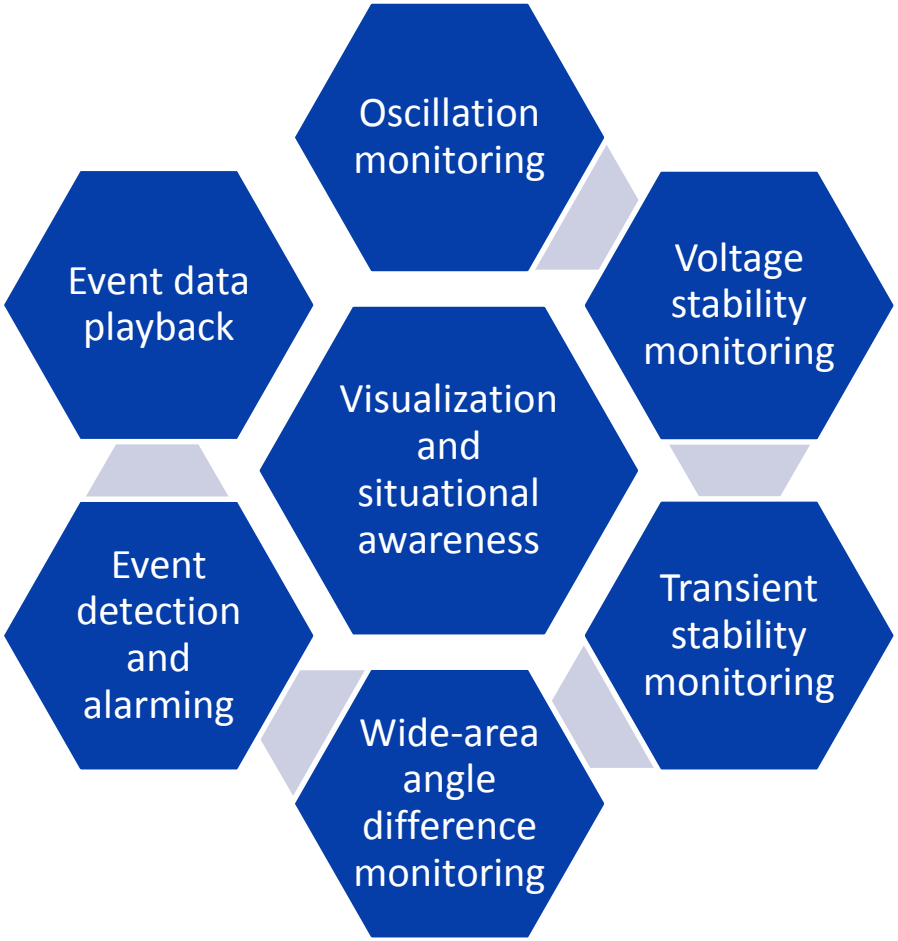
- Release 1 (11/18/2015), Dashboard, oscillation tool, voltage stability tool
- Release 2 (3/9/2016), Event detection and alarm triggers and archival
- Release 3 (7/27/2016), Angle instability tool, angle difference monitoring tool
- Release 3.1 (8/31/2016), Final release

Project Achievements (cont.)

Performed extensive off-line validation of analytical engines	• Using transmission planning model • PSSE simulation of known events • Validating based on different stability category
Performed comprehensive evaluation of software on-line performance	• Bi-weekly WebEx demo to demonstrate software performance based on real-time data • Receive feedbacks from all stakeholders at the on-line demo • Address feedbacks quickly
Training materials and training sessions	• Facilitated by off-line validation effort • For different user groups

GSAS Design Considerations

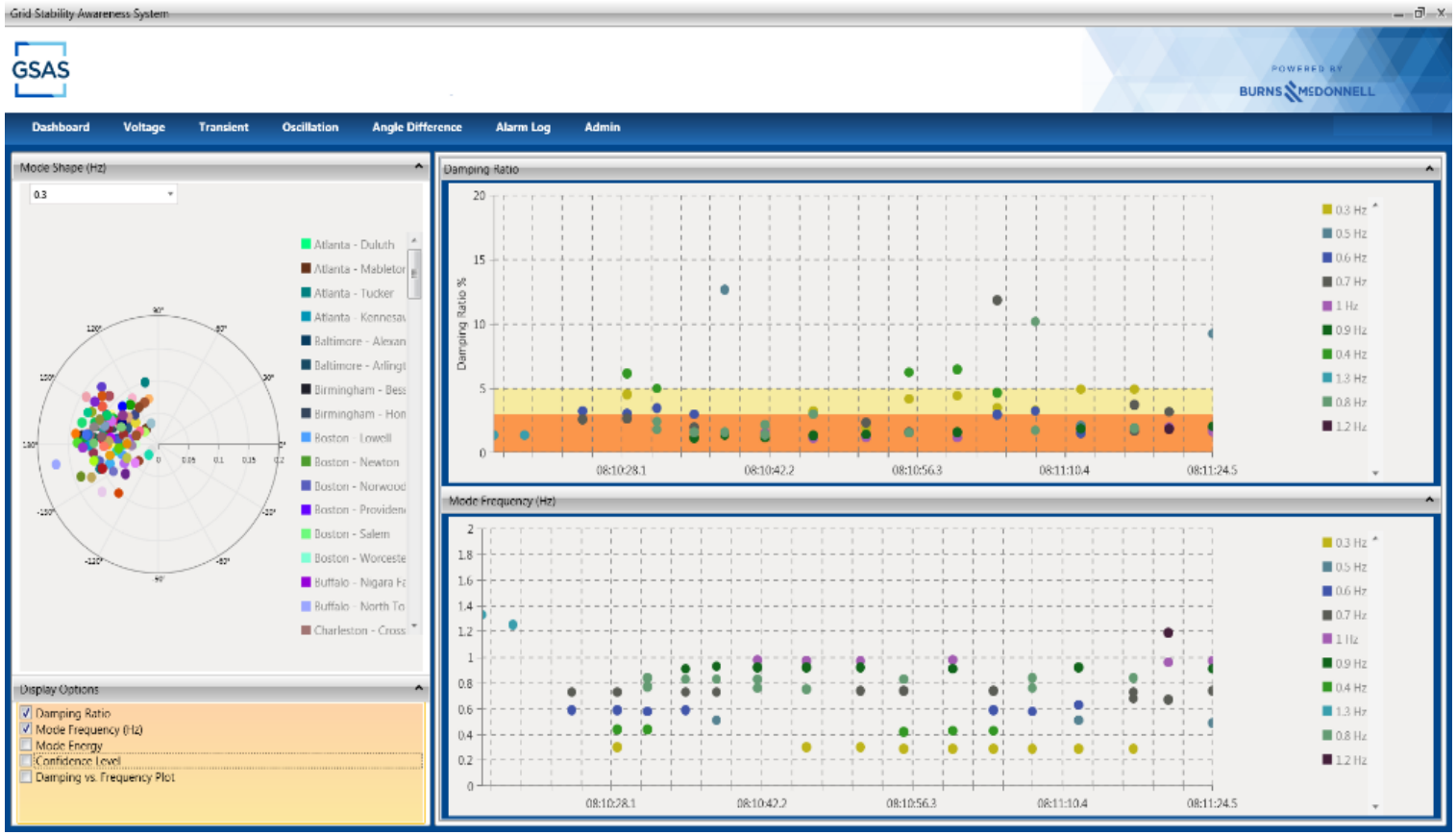
- Operator view oriented
  - Real-time data streams
  - Event triggers
- Scalable for larger numbers of PMUs
- Extensible framework for new functionality
  - Stability monitoring
  - Dynamic response validation
  - Wide-area awareness
- Server / Client structure



GSAS Modules Implemented

Oscillation Monitoring

- Mode frequency, damping ratio, mode energy, confidence level, mode shape for each mode
- Playback of historical alarm data



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Voltage Stability Monitoring

- Local/remote voltage stability index and confidence level for each line
- User selectable signals based on locations and voltage levels
- Playback of historical alarm data

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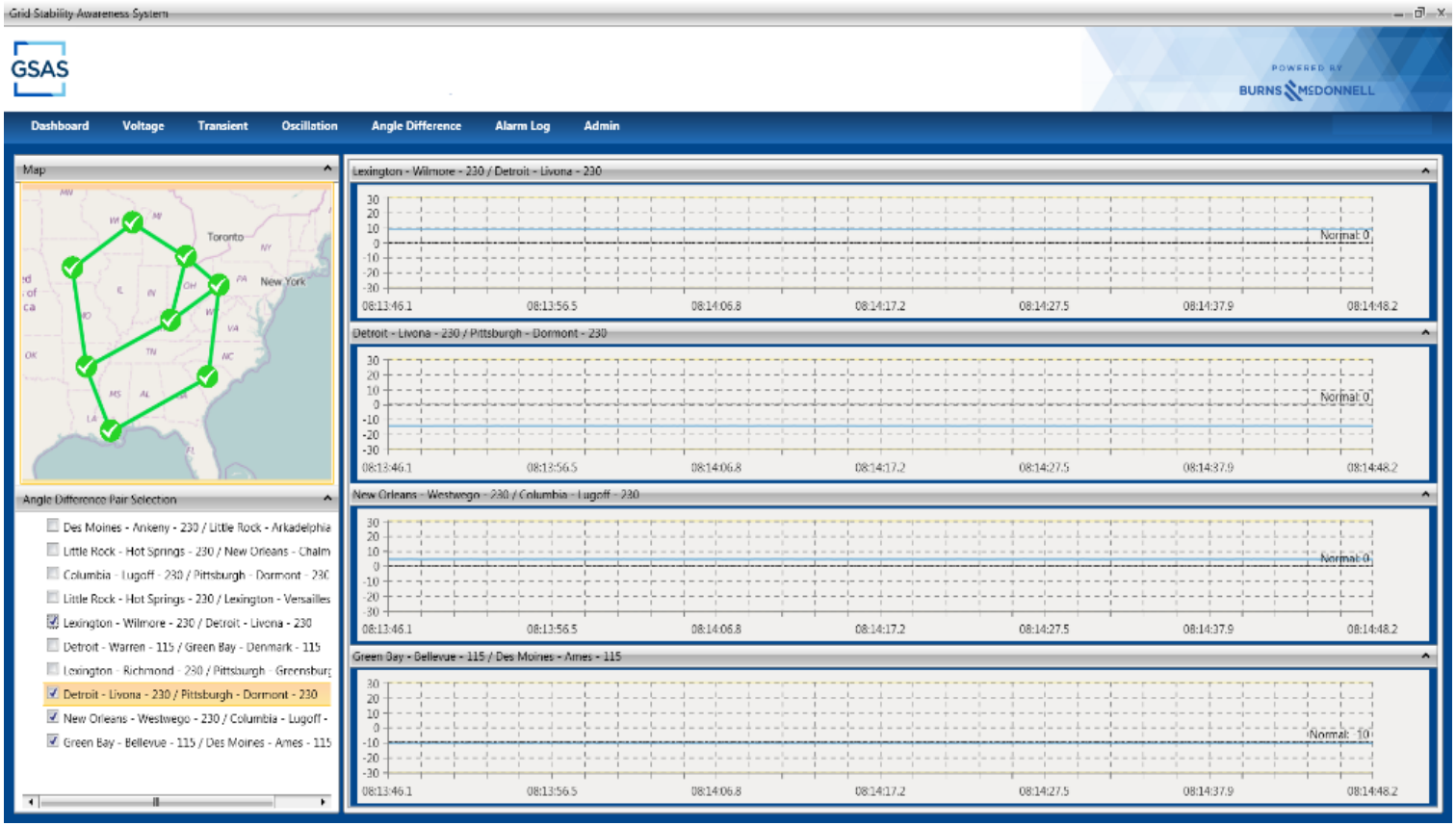
Angle Difference Monitoring

- Angle difference for each user-defined angle difference pair
- Playback of historical alarm data



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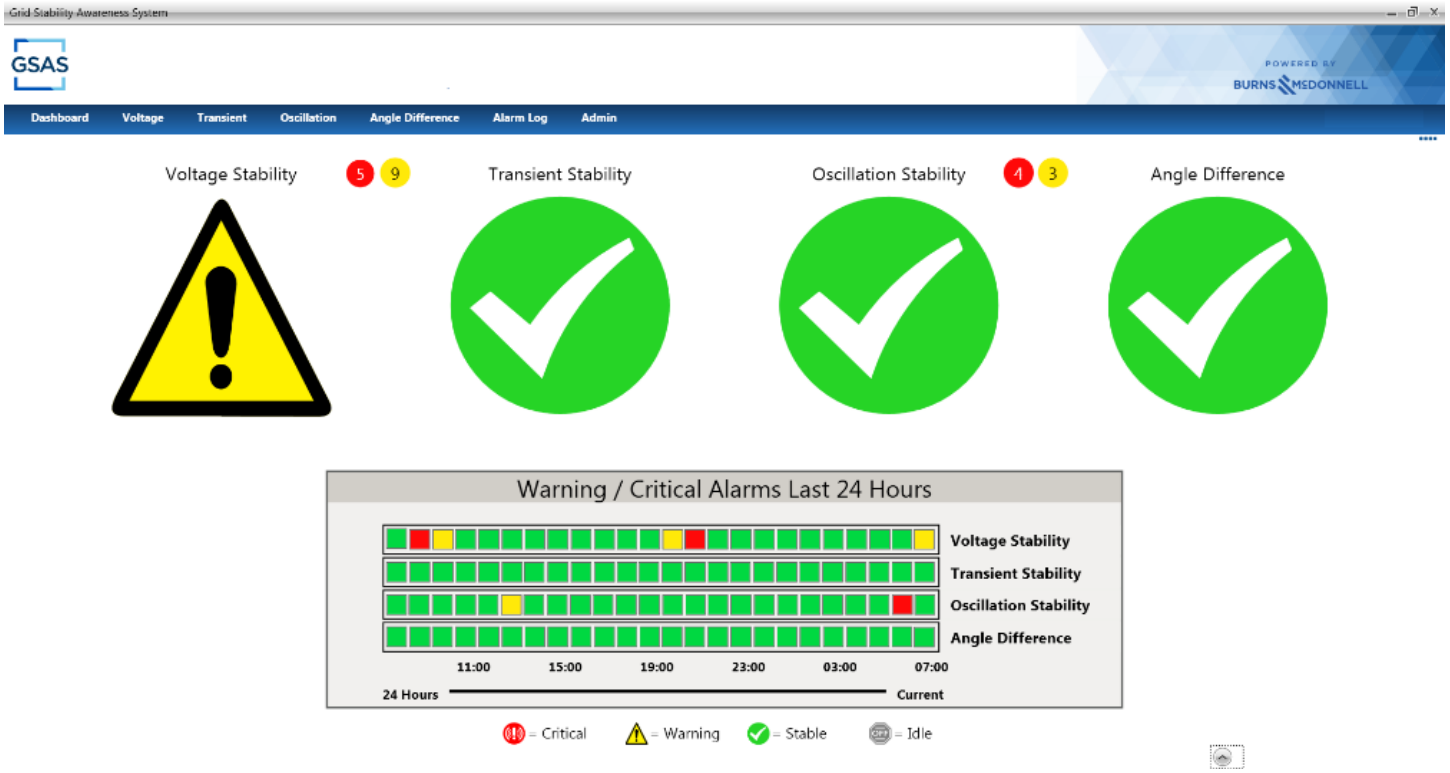
GSAS Alarm Mechanisms

Oscillation Stability Alarming	• Real time modal analysis (damping ratio, mode frequency, mode shape, mode energy) • User-configurable damping ratio limit and confidence thresholds
Voltage Stability Alarming	• Real time voltage stability index based on deltaQ/deltaV sensitivity • User-configurable voltage stability limits and confidence thresholds
Transient Stability Alarming	• Real time angle separation after transient event • User-configurable generator clusters
Angle Difference Alarming	• Real time phase angle difference • User-configurable phase angle difference limits

GSAS Alarming Dashboard

- Real-time status of system stability
- Historical (last 24 hours) status of system stability
- User clickable event/alarm retrieval
- Event/alarm log and acknowledgements



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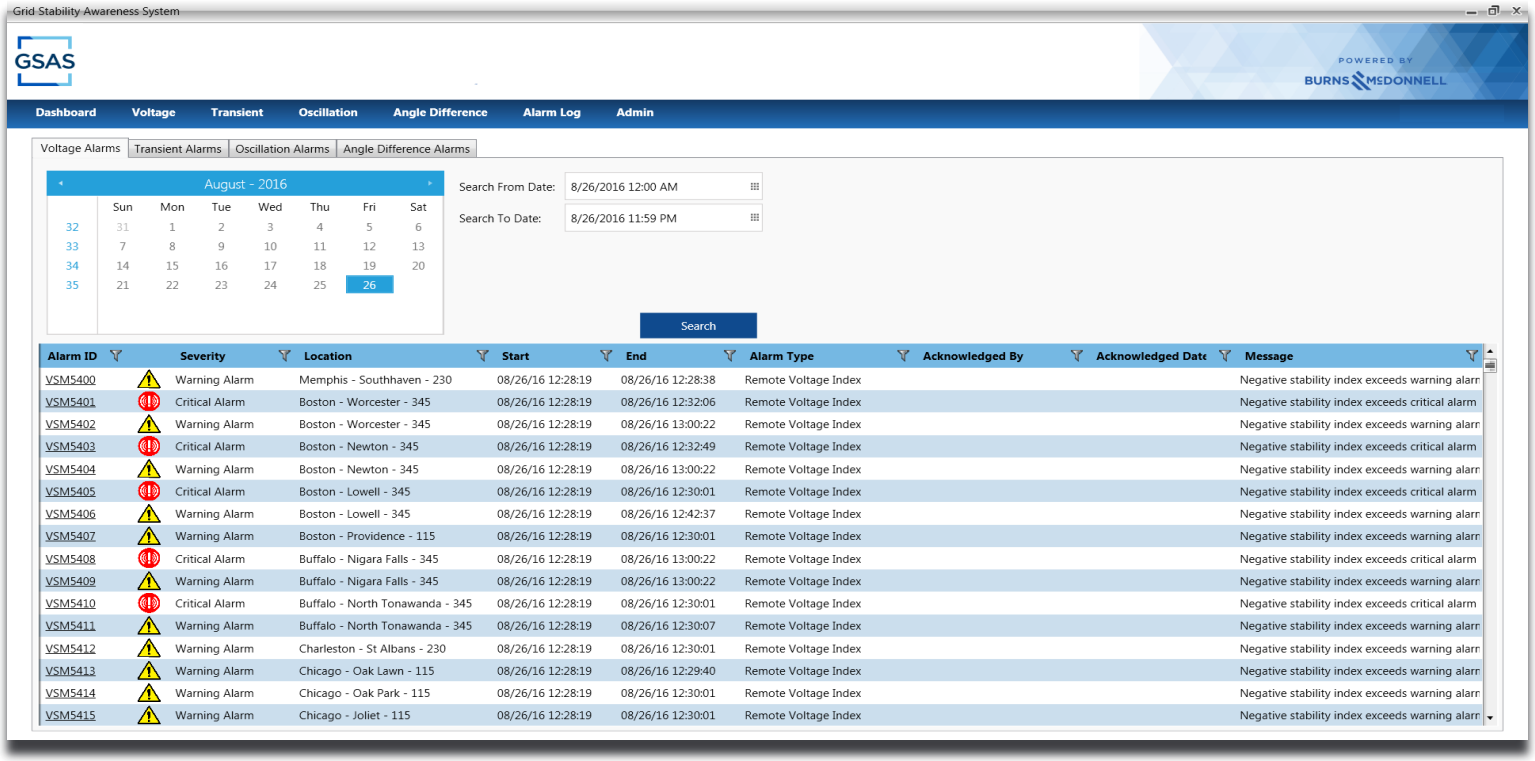
Historical Alarm Playback

- Alarms captured for playback mode (configurable)
- Alarm logs and operator acknowledgements
- Alarm filtering, grouping, and report generation
- Post-event replay and analysis



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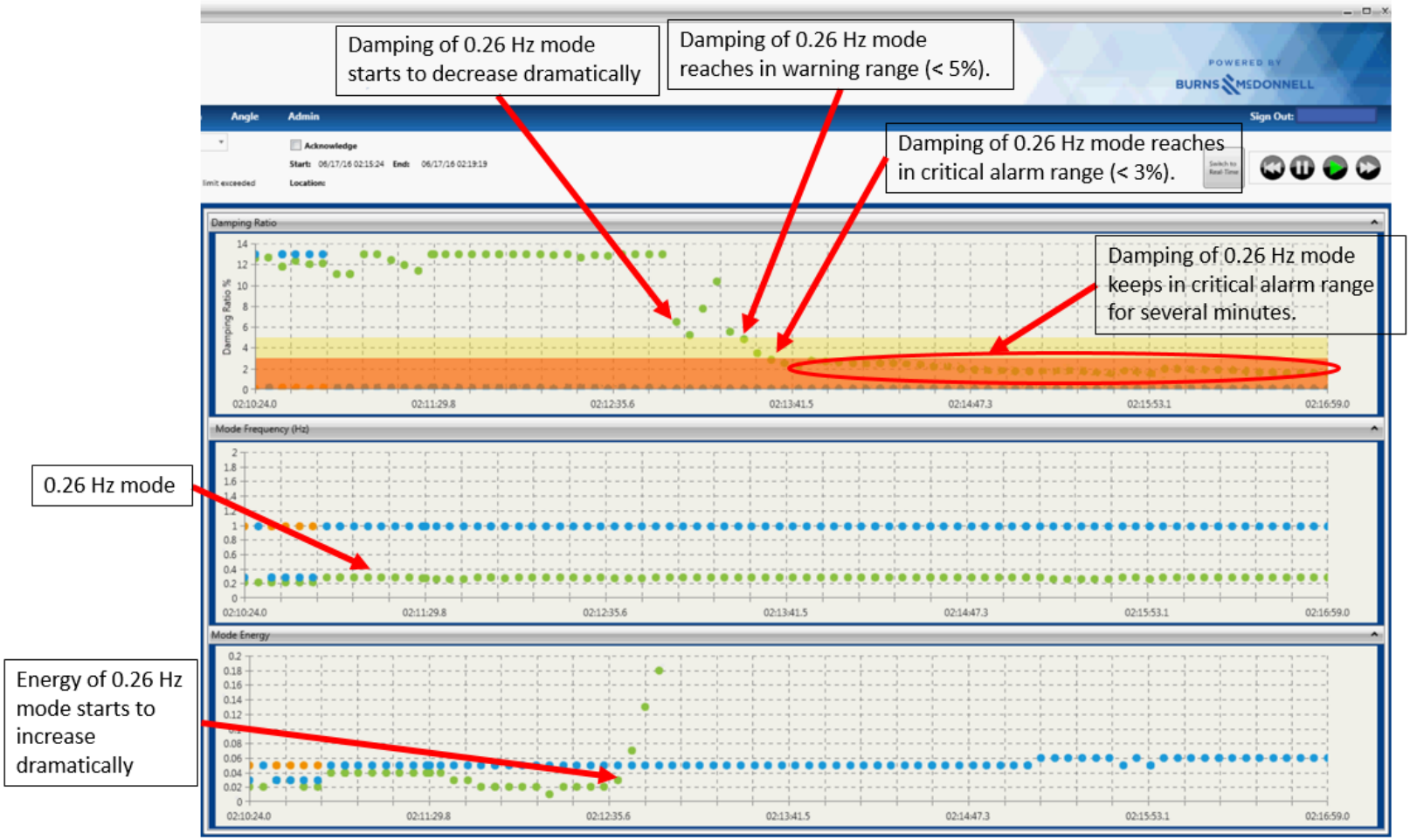
Actual Oscillation Event Detected

Event Date: June 17, 2016

This event occurred outside of Southern Company's footprint…



Project Progress

- Key Milestones (as of October, 2016)

Milestones	Estimated Completion
Project Kick-off meeting at Southern Company	Complete
An on-site interview meeting at Southern Company	Complete
Draft software requirement specifications	Complete
Define software roadmap and plans for development and deployment	Complete
Develop and refine analytical tools (engines)	Complete
Release 1 of GSAS	Complete
Release 2 of GSAS	Complete
Release 3 of GSAS	Complete
Complete training materials and user manuals	On going
Complete grid operator training sessions	On going
Complete topical report on software off-line validation	On going
Complete topical report on evaluation of software on-line performance	On going

THANKS

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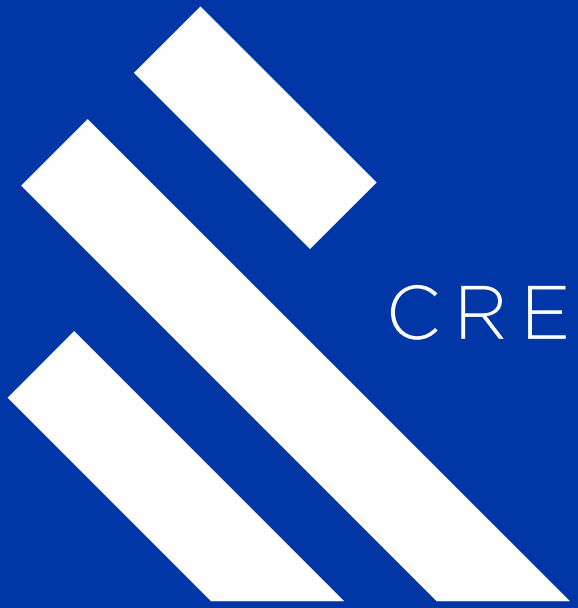

CREATE AMAZING.